Forest Health Conditions in Hawaii – 2004

Tropical forests in Hawaii provide critical habitat to endangered plants and animals and vital watershed services. Oceanic islands are characterized by geographic isolation, high levels of species endemism, limited spatial extent, and heterogeneous landscapes, all of which make island ecosystems particularly vulnerable to exotic species impacts. The introduction and spread of invasive species is one of the major threats to the health and biodiversity of these ecosystems.

The location of Hawaii in the center of major trade routes between Asia, Australia and the Americas has led to the deliberate and accidental introduction of a multitude of invasive plants and animals from many parts of the globe.

Hawaii's location in the center of shipping routes in the Pacific is increasing the inadvertent movement of invasive species.

More than 8,000 plant species and cultivars have been introduced into gardens and other areas in Hawaii. Over half of Hawaii's current flora of 2000 or so flowering plants are non-native, naturalized species and almost ten percent of these represent serious threats to Hawaii's native ecosystems. Many plant communities are now dominated by introduced species and some species, such as strawberry guava (*Psidium guajava*), form monospecific stands over large areas of the State. The sheer number of invasive species coupled with Hawaii's resource-based economy results in a significant economic impact to the State. Trade is increasingly global and it is unlikely that it will decrease in the near future. We can, therefore, expect the current trend of 40 new plant species introductions to Hawaii per year to remain stable or increase over time unless the economy weakens or additional safeguards are put in place.

Most of the early efforts at control of introduced species in Hawaii centered on selective control of feral ungulates by land managers, particularly in Hawaii's national parks. Within the last decade, control of invasive weeds has become a state-wide priority. Over $28 million is spent in Hawaii by federal, state and local governments and private entities on prevention, control and research of terrestrial and aquatic invasive species. Cooperative efforts are organized state-wide by the Coordinating Group of Alien Pest Species (CGAPS) and the Hawaii Invasive Species Council (HISC) and locally by public-private partnerships organized into Invasive Species Committees (ISCs) on each island. Following is a report of the status of on-going control programs for the principal plant invaders in Hawaii.

Invasive Plants

Invasive plants are non-native plants that escape cultivation and maintain self-reproducing populations (naturalized). Invasive species of concern are those that have, or are predicted to cause significant negative impacts to human health, the environment or the local economy. With Hawaii's high number of threatened and endangered species, "environmental weeds" or those species that alter ecological communities or ecosystem properties and displace native species, threaten biological diversity and are of special interest to forest health.

Several strategies are employed for control of invasive plants in Hawaii. Hawaii's land managers are using a "site-led" approach to protect valuable forests and wildlife habitat. Hawaii Division of Forestry and Wildlife (DOFAW) controls certain invasive species in its Natural Area Reserves and

in some of its Forest Reserves. The National Park Service controls a suite of invasive plants within "special ecological areas" of high resource value. Hakalau National Wildlife Refuge continues to control Florida prickly blackberry (*Rubus argutus*)to protect and restore critical habitat for Hawaii's endangered forest birds. Large scale private efforts to control invasive plants occur on lands owned by the Nature Conservancy of Hawaii and the Kamehameha Schools Trust. Local watershed partnerships and neighborhood associations are also actively controlling weeds in certain key areas.

DOFAW accomplishes much of its early detection and rapid response work through funding the island Invasive Species Committees. Control strategies for the ISCs are "weed-led". The current focus is on early detection and rapid response of incipient weeds – relatively new introductions with very limited distribution – on state and private lands in Hawaii. Control and containment of important widespread ecosystem-altering weeds, such as miconia, is also part of the ISC program.

Several projects dealing with exploration for and the introduction and release of biological control agents to control several widespread, damaging forest weeds are underway. Exploration for insects to control strawberry guava and miconia is underway with biologists from the U.S.D.A. Forest Service and cooperators in Brazil and Costa Rica. The U.S.G.S. Biological Resources Division is working with a plant pathogen as a possible bio-herbicide for control of kahili ginger. The Hawaii Department of Agriculture has released a leaf spot fungus for control of banana poka (Septoria passiflorae) and is working with the Hawaii Division of Forestry and Wildlife on another pathogen with hopes of controlling clidemia.

Plant Diseases

Koa Wilt Disease

Koa wilt, first isolated in 1980, is a vascular wilt disease caused by a fungal infection in tree roots by *Fusarium oxysporum* f.sp. *koae*. Preliminary results from an on-going survey verify its presence on all of the major Hawaiian Islands in both plantation and natural forests. Koa wilt appears more virulent in lowland sites (under 3000 feet) where forestry plantings and restoration efforts are affected. Trees planted in former sugar cane fields have been found to be particularly susceptible. Genetic resistance to the disease is being investigated with inoculation trials underway.

Table 1. Invasive Plant Surveys funded by Forest Health Protection Prevention and Suppression Funds in Hawaii for 2004.

Island Invasive Species Committee	Acres Surveyed
Big Island Invasive Species Committee	13,337
Kauai Invasive Species Committee	5,174
Maui Invasive Species Committee	31,608
Molokai Invasive Species Committee	797
Oahu Invasive Species Committee	3,690

Table 2. Top Invasive Plant Species Controlled by Island Invasive Species Committees in Hawaii in 2004

Common Name	Scientific Name	Family	Infest †	Location of control efforts◘	Control strategies
Rubber vine	*Cryptostegia grandiflora*	Asclepiadaceae	L	Mo	Control
Fireweed	*Senecio madagascariensis*	Asteraceae	W	K	Eradication
Butterfly bush; smoke bush	*Buddleia madagascariensis*	Buddleiaceae	L	O	Control; Eradication
Ivy gourd	*Coccinia grandis*	Cucurbitaceae	L	K; M	Control
Cat's claw	*Caesalpinia decapetala*	Fabaceae	L	Mo	Control
Long Thorn kiawe	*Prosopis juliflora*	Fabaceae	L	K	Control
New Zealand Flax	*Phormium tenax*	Linaceae	L	Mo	Control
Miconia	*Miconia calvescens*		W	H; K; M; O	Contain, Control, Eradicate
Privet	*Ligustrum sinense*	Oleaceae	L	K	Control
Giant Reed	*Arundo donax*	Poaceae	L	K; M	Control
Pampas grass	*Cortaderia jubata & C. selloana*	Poaceae	L	M; M; Mo	Control, Eradication
Fountain grass	*Pennisetum setaceum*	Poaceae	W	L; M; Mo; O	Control, Eradication
Bush beardgrass	*Schizachrium condensatum*	Poaceae	W	O	Control
Himalayan blackberry	*Rubus discolor*	Rosaceae	L	O	Control, Eradication
Water wattle*	Acacia retinodes	Fabaceae	I	M	Eradication
Bingabing*	Macaranga mappa	Euphorbiaceae	I	M	Eradication
Parasol leaf tree*	Macaranga tanarius		I	M	Eradication
Firetree*	Morella faya	Mrytaceae	I	M	Eradication
Pittosporum*	Pittosporum viridiflorum	Pittosporaceae	I	M	Eradication
Downy rose myrtle*	*Rhodomyrtus tomentosa*	Myrtaceae	I	M	Eradication

†Type of Infestation:	I = Incipient infestations on single or multiple islands; L = Limited distribution statewide but may be locally abundant; W = Widely distributed on one or more islands
◘ Locations: H = Hawaii; L = Lanai; K = Kauai; M = Maui; Mo = Molokai; O = Oahu	
* Efforts at Eradication of Selected Incipient Species on Maui by the Maui Invasive Species Committee	

Table 2. List of on-going Biological Control Efforts in Hawaii in 2004

Common Name	Scientific Name	Family	Infest †	Location of control efforts¤
Gorse	*Ulex europaeus*	Fabaceaae	W	H; Mo
Banana poka	*Passiflora tarminiana*	Passifloraceae	W	H; K
Koster's Curse	*Clidemia hirta*	Melastomataceae	W	H, K
Strawberry guava	*Psidium cattleianum*	Myrtaceae	W	
Kahili ginger	*Hedyichium gardnerianum*	Zingerberaceae	W	K; H
†Type of Infestation	I = Incipient infestations only in H; L = Limited distribution in H but may be locally abundant; W = Widely distributed on one or more islands			
¤ Locations: H = Hawaii; L = Lanai; K = Kauai; M = Maui; Mo = Molokai; O = Oahu				

Species Highlights and Profiles
Miconia *Miconia calvescens* DC

The rampant spread of this introduced plant on Tahiti, where it occurs on over 65% of the island and forms dense monospecific stands on 25% of the island, alarmed conservationists and biologists in Hawaii. Agencies and individuals long interested in invasive species control in Hawaii galvanized around the threat of miconia and other melastome species in the early 1990's, forming Melastome Action Committees on Maui and Hawaii. Miconia continues to be the highest priority weed for control in Hawaii. Miconia threatens mesic and wet habitats in Hawaii that receive more than 75 to 80 in. of annual rainfall. Trees flower after only 4 to 5 years and a single large (30 ft.) mature tree is capable of producing up to 3 million seeds several times a year. Seeds are dispersed by birds and pigs. It currently occupies large acreages on Hawaii (110,000) and Maui (30,000) where control strategies focus on stopping the spread of miconia (containment) with some reduction of the core population (on Maui). The Maui Invasive Species Committee surveyed 34,000 acres for miconia and treated 236,000 plants on 135 acres of the infestation. Miconia is considered to be incipient on Kauai and Oahu where eradication is the goal and areas with controlled populations are closely monitored.

Crews from the Big Island and Maui Invasive Species Committees continue control of *Miconia calvescens*, Hawaii's top priority forest weed.

Efforts are also underway by the U.S. Forest Service and "in-country" collaborators to search for biological control agents in the native range in Brazil and Costa Rica. Promising agents include a defoliating caterpillar (*Euselasia chrysippe*, Riodininae), a shoot-feeding psyllid (*Diclidophlebia lucens*, Psyllidae), a stem-mining weevil (*Cryptorhynchus melastomae*, Curculionidae), a fruit borer (*Anthonomus monostigmata*, Curculionidae), a leaf pimple fungus (*Coccodiella miconiae*, Phyllachoraceae) and a leaf and shoot-galling nematode (Ditylenchus sp.).

Larvae of *Euselasia chrysippe*, a promosing biological control agent for *Miconia calvescens,* causes severe defoliation during host testing in Costa Rica.

Fountain Grass
Pennisetum setaceum (Forssk.) Chiov.
Fountain grass is a fire-adapted introduced grass that is changing fire regimes and outcompeting native species in Hawaii. It covers more than 200,000 acres on the island of Hawaii, threatening the remaining dry forest communities on leeward slopes. Efforts to control or eradicate fountain grass are on-going on Kauai, Lanai, Maui and Oahu where it is present in limited extent. Conventional control is not deemed feasible on Hawaii. Current research on forest restoration techniques holds promise for replacement of fountain grass with native understory species and ecosystem restoration on a landscape level. Reduction in fountain grass cover would also reduce fire occurrence in some of Hawaii's most fire prone areas. Conventional biological control is also being explored by the Hawaii Department of Agriculture.

Fountain grass, *Pennisetum setaceum*, covers over 200,000 acres on the island of Hawaii, increasing fire potential and severely impacting critically endangered dry forests.

Pampas Grass
Cortaderia jubata (Lemoine ex Carrière) Stapf

Pampas grass is a large ornamental grass introduced as an attractive ornamental and is still popular in landscaping and still sold in garden centers throughout Hawaii.

Cortaderia jubata is both a Federal and Hawaii listed noxious weed and is considered a serious pest in New Zealand and California. On Maui it has naturalized and, although the acreage infested is still limited, it exhibits a wide ecological tolerance ranging from IaoValley on West Maui to Haleakala Crater on East Maui at elevations from 2,000 ft. to almost 7,000 ft. Efforts at controlling this species on Maui continue but have proven to be difficult and long-term. This species is targeted for local control and eradication on Kauai, Hawaii, and Molokai. On Oahu it is only known from ornamental plantings. Efforts at encouraging voluntary removal or ornamental plants are underway. A related species of pampas grass that is very similar in appearance but less invasive species, *C. selloana*, is present in Hawaii and is also used extensively in landscaping.

Many of Hawaii's worst weeds were introduced as attractive ornamentals and are still used for residential or commercial landscaping. These plants later invade native forests and become conservation problems.

Banana poka

Passiflora tarminiana Coppens & V.E. Barney (= *P. mollissima*)

This vine was one of Hawaii's worst weed 25 years ago, covering nearly 125, 000 acres on the island of Hawaii, and is still a significant pest in mid-elevation wet and mesic forest on Kauai, Hawaii, and Maui, where it is capable of smothering trees. In 1996 and 1997 a leaf spot fungus (*Septoria passiflorae*) was released on Hawaii, Kauai and Maui by the Hawaii Division of Forestry and quickly established. In the Hilo Forest Reserve where this pathogen has been most effective, the Hawaii Division of Forestry has recorded a reduction of 80-90% of plant biomass on 5,000 acres. To date, the pathogen does not appear to be equally effective in other areas.

Banana poka (*Passiflora tarminiana*) has smothered mid elevation native forests on Kauai and Hawaii but is on the decline is some areas as a result of the introduced leaf spot pathogen, *Septoria passiflorae.*

Clidemia or Koster's Curse
Clidemia hirta (L.) D. Don
Clidemia, which occurs on all major islands in Hawaii, is a serious pest of mesic and wet forests up to 5000 ft. in elevation. Clidemia produces large quantities of seeds which are readily spread by birds and feral pigs. It has invaded disturbed and undisturbed forests. All of the common species in this family are on the Hawaii Noxious Weed list. A defoliating pathogen (*Colletotrichum gloeosporoides* f.sp. *clidemiae*) is currently being evaluated for its efficacy in controlling clidemia. Preliminary releases and monitoring of the pathogen by the Hawaii Division of Forestry and Wildlife in the Hilo, Kohala and Kau areas of Hawaii and on Kauai are ongoing.

Downy Rose Mrytle
Rhodomyrtus tomentosa (Aiton) Hassk.

Downy rose myrtle is an attractive ornamental often spread by gardeners. It can be found in moist and wet forests and bog margins, up to 3000 ft. elevation in Hawai'i. Although widespread on Hawaii and Kauai, a recent early detection and rapid response on Maui eradicated the three known populations there. Monitoring for new infestations continues on Maui. Local eradication of downy rose myrtle is occurring in Kokee State Park on Kauai. On the rest of Kauai and on Hawaii, populations continue to spread unabated.

Early detection and rapid response was responsible for the possible eradication of downy rose myrtle (*Rhodomyrtus tomentosa*) on Maui.

Kahili Ginger
Hedychium gardnerianum Sheppard ex Ker Gawl.

Kahili ginger is an attractive herb with showy yellow flowers which grows over five feet in height. It is currently invading wet forest on Lanai, Kauai, Hawaii and Maui and can form dense, monospecific stands, even in closed forests. Efforts to control Kahili ginger in localized areas are on-going at Hawaii Volcanoes National Park on Hawaii and at Kokee State Park on Kauai, with some successes. In addition, the U.S. Geological Survey is conducting studies on the efficacy of a bacteria used as a bio-herbicide and its potential for more widespread control of kahili ginger.

A bio-herbicide is under development for the control of kahili ginger, a serious pest of wet forests.